

**Fishery Data Series No. 91-16**

---

**A Study of Coho Salmon in Southeast Alaska, 1990:  
Salmon Lake, Eagle River, St. John and Sinitzin  
Creeks**

**by**

**Artwin E. Schmidt  
and  
John A. DerHovanisian**

July 1991

---

Alaska Department of Fish and Game

Division of Sport Fish



FISHERY DATA SERIES NO. 91-16

A STUDY OF COHO SALMON IN SOUTHEAST  
ALASKA, 1990: SALMON LAKE, EAGLE RIVER,  
ST. JOHN AND SINITSIN CREEKS<sup>1</sup>

By

Artwin E. Schmidt  
and  
John A. DerHovanisian

Alaska Department of Fish and Game  
Division of Sport Fish  
Anchorage, Alaska

July 1991

<sup>1</sup> This investigation was partially financed by the Federal Aid in Sport Fish Restoration Act (16 U.S.C 777-777k) under Project F-10-6, Job No. S-1-4.

The Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Fishery Data Series reports are intended for fishery and other technical professionals. Distribution is to state and local publication distribution centers, libraries and individuals and, on request, to other libraries, agencies, and individuals. This publication has undergone editorial and peer review.

The Alaska Department of Fish and Game operates all of its public programs and activities free from discrimination on the basis of race, religion, color, national origin, age, sex, or handicap. Because the department receives federal funding, any person who believes he or she has been discriminated against should write to:

O.E.O.  
U.S. Department of the Interior  
Washington, D.C. 20240

# TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES . . . . .	ii
LIST OF FIGURES . . . . .	ii
LIST OF APPENDICES . . . . .	ii
ABSTRACT . . . . .	1
INTRODUCTION . . . . .	2
METHODS . . . . .	4
Estimates of Smolt and Presmolt Abundance . . . . .	4
Adult Escapement . . . . .	5
Estimated Harvest . . . . .	6
Juvenile Population Estimates . . . . .	7
RESULTS . . . . .	8
Salmon Lake . . . . .	8
Eagle River . . . . .	11
Juvenile Population Estimates . . . . .	15
DISCUSSION . . . . .	15
ACKNOWLEDGMENTS . . . . .	19
LITERATURE CITED . . . . .	20
APPENDIX A . . . . .	21

## LIST OF TABLES

<u>Table</u>	<u>Page</u>
1. The estimated harvest of Salmon Lake coho salmon by the commercial fishery by statistical week and by period in 1990 . . . . .	9
2. Mean length (mm mid-eye to fork of tail), age, and sex composition of age-0.1 adult coho salmon sampled at Salmon Lake weir, 26 August to 29 September 1990 . . . . .	10
3. Mean fork length (mm) and age composition of coho salmon smolts sampled at Salmon Lake weir, 22 March to 19 May 1990 . . . . .	12
4. The estimated harvest of Eagle River coho salmon by the commercial fishery by statistical week and by period in 1990 . . . . .	13
5. Mean fork length (mm) and age composition of coho salmon smolts sampled at Eagle River, 20 April to 20 May 1990 . . . . .	14
6. Population estimates, age composition, and mean length at age of juvenile coho salmon $\geq 65$ -mm fork length at Sinitsin and St. John Creeks, July 1990 . . . . .	16
7. Daily catch and number of unmarked juvenile coho salmon $\geq 65$ -mm length, by day, at Sinitsin and St. John Creeks, July 1990 . . . .	17
8. Summary of available juvenile-per-spawner production ratios for coho salmon from Sinitsin and St. John Creeks, 1985 to 1990. . . . .	18

## LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
1. Coho salmon research sites near Sitka in 1990 . . . . .	3

## LIST OF APPENDICES

<u>Appendix</u>	<u>Page</u>
A1. Daily counts of coho salmon, water temperature, stream depth, and rainfall at the Salmon Lake weir, 1990 . . . . .	22
A2. Daily catches of fish and measurements of rainfall, water temperature, and maximum stream depth at the site of the fyke net on the outlet stream from Salmon Lake, 1990 . . . . .	23
A3. Daily catches of fish and measurements of water temperature and maximum stream depth at the site of the fyke net on Eagle River, 1990 . . . . .	25

# ABSTRACT

Investigations of coho salmon *Oncorhynchus kisutch* at Salmon Lake, Eagle River, Sinitzin Creek, and St. John Creek in Southeast Alaska continued in 1990. The escapement of adult salmon to Salmon Lake was 204 fish. Commercial harvest of this stock by the troll fishery was 68.1 percent of the adult production. Smolt-to-adult survival rate was an estimated 8.2 percent during 1989 to 1990. The coho presmolt population at Salmon Lake was an estimated 15,414 fish. Escapement of coho salmon to Eagle River was 214 fish, while the troll fishery harvested an estimated 58.7 percent of adult production. Smolt-to-adult survival rate during 1989 to 1990 was 5.1 percent for adults returning to Eagle River. Estimates of age-1. juvenile coho salmon abundance in Sinitzin and St. John Creeks were 1,470 and 540 fish, respectively. The number of age-1. juvenile coho salmon per parent was 26.2 in Sinitzin Creek and 7.6 in St. John Creek.

KEY WORDS: coho salmon, *Oncorhynchus kisutch*, escapement, production, return, smolt, age-weight-length composition, harvest rate, fishery contribution, troll fishery, sport fishery, Southeast Alaska, Sitka, Baranof Island, Kruzof Island.

## INTRODUCTION

The purpose of the stock assessment program for coho salmon *Oncorhynchus kisutch* in Southeast Alaska is to improve the management of sport fisheries on the coho salmon stocks in the region. Improving management involves optimizing the harvest of returning adults and providing for adequate levels of escapement. Data were collected to address three goals:

1. Estimate desired escapement goals from spawner-return and/or spawner-recruit production models.
2. Estimate time and area of harvest and harvest rate of adults.
3. Develop models to forecast the run-strength of stocks based on the expected ocean survival rates of smolt and/or the catch of adults returning in the first few weeks of the fishery.

In 1990, data were collected on four coho salmon stocks near Sitka as representatives of the stocks from the northern outside quadrant of Southeast Alaska (Figure 1). Stocks rearing and returning to:

1. Salmon Lake represent lacustrine stocks in the outer coastal area. Research at this site has been ongoing since 1983 (Schmidt 1984, 1985, 1986, 1987, 1988, 1990; Elliott et al. 1989).
2. Eagle River represent riverine stocks in the Sitka area. Studies of smolt at this location show stream-produced smolts are of different ages and sizes than lake-produced smolts (Elliott et al. 1989; Schmidt 1990).
3. Sinitzin and St. John Creeks represent stocks from small streams around Sitka Sound (Elliott et al. 1989; Schmidt 1990). The escapements in these streams have varied from less than 10 to over 100 adults during the last 6 years. Possible correlations between adult escapement and subsequent juvenile production is being investigated. Desired escapement goals will be determined from this relationship.

Objectives for the program in 1990 were to:

1. count the escapement of age-.1 adult coho salmon to Salmon Lake from 15 August to 15 October and Eagle River from 15 August to 1 November;
2. estimate the age and sex composition of adult coho salmon at Salmon Lake;
3. estimate the mean length of adults at Salmon Lake;
4. estimate the 1990 harvest of coho salmon bound for Eagle River and Salmon Lake in all fisheries;
5. estimate the number of coho salmon smolt leaving between 15 March and 15 June from Salmon Lake and between 15 April and 15 June 1990 from Eagle River;

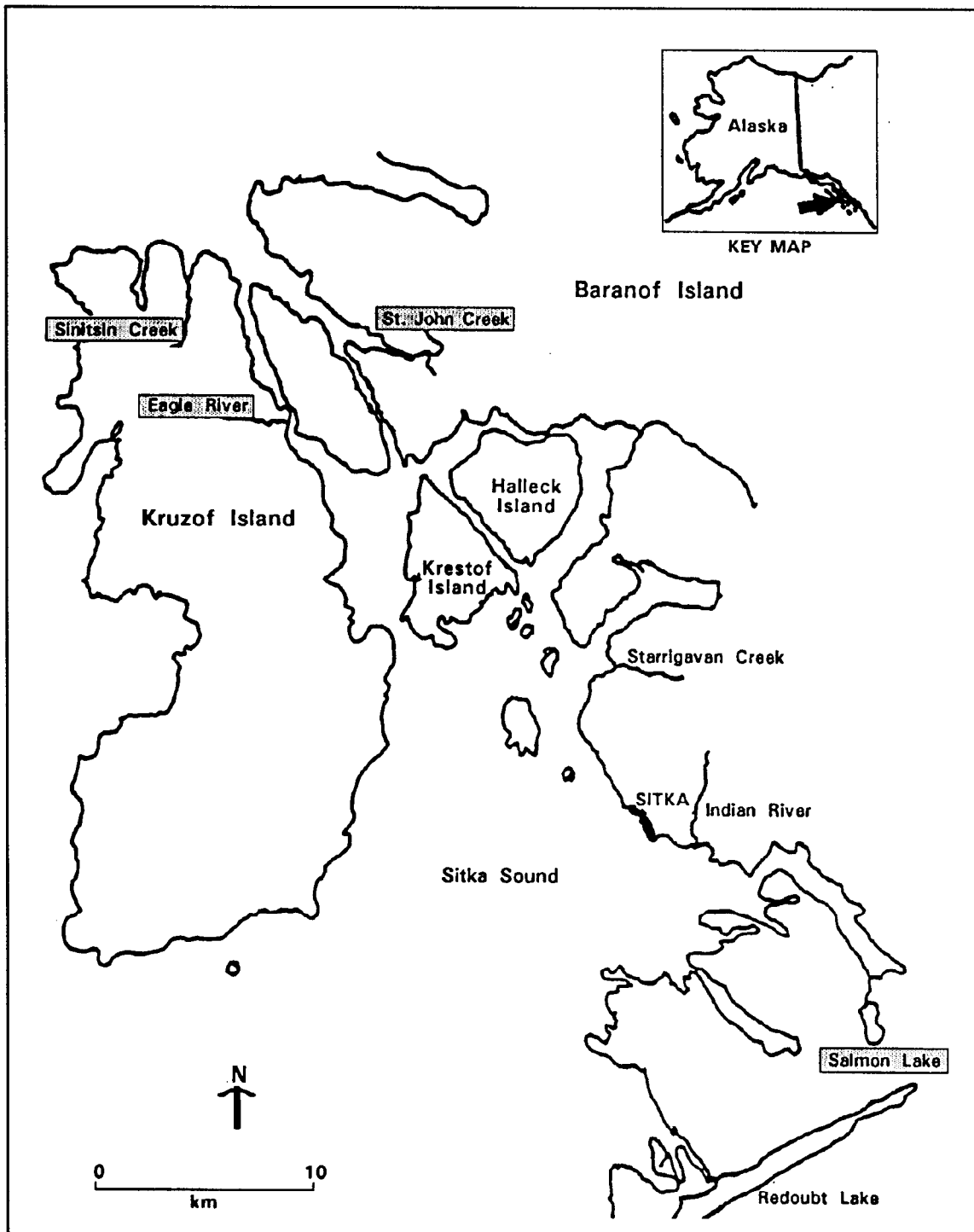


Figure 1. Coho salmon research sites near Sitka in 1990.



6. estimate the number of coho salmon presmolt in late March in Salmon Lake;
7. estimate the mean length of smolt emigrating from Eagle River and Salmon Lake;
8. estimate the age composition of coho salmon smolt emigrating from Eagle River and Salmon Lake;
9. estimate the number of coho salmon juveniles  $\geq 65$  mm (aged 1. and older) in St. John and Sinitzin Creeks during July;
10. estimate the age composition of coho salmon juveniles aged 1. and older in St. John and Sinitzin Creeks during July; and
11. estimate the mean length at age for coho salmon juveniles aged 1. and 2. in St. John and Sinitzin Creeks during July.

## METHODS

### Estimates of Smolt and Presmolt Abundance

Smolt were captured at Eagle River and Salmon Lake using stream-type fyke nets with a live box. Fyke nets were fished just above tidewater at Eagle River and just below the lake outlet at Salmon Lake. Fyke nets were 1 x 1 m and about 3 m long; the cod end was attached to a 10-cm (4 in) plastic flex pipe that led to a floating live box. Two nets were fished at each site. Leads constructed of 1.27-cm (0.5 in) rebar frames hung with 0.63-cm (0.25 in) vexar were constructed at about a 45° angle upstream such that most of the stream was fished. At Salmon Lake panels were separated to allow upstream migration of adult steelhead *O. mykiss*. Water depth (nearest cm) and water temperature (nearest 0.5°C) were taken from 0800 to 1800 daily. Smolts were captured from 22 March to 19 May at Salmon Lake and from 20 April to 20 May at Eagle River during 1990. They were counted, tranquilized with tricaine methane sulfonate (MS 222), marked by complete removal of their adipose fin, and tagged with a coded-wire tag (CWT) following the instructions of Koerner (1977).

A systematic sample of smolt was taken at each site for age-length analysis. Every 15th smolt removed from the fyke net was sampled at Salmon Lake, and every 5th smolt at Eagle River. Each sampled fish was measured to the nearest 1-mm fork length. Scales were removed from the preferred area of each fish (Anas 1963), applied to a microscope slide, covered with a second slide, and secured at both ends with "scotch tape." Up to four sets of scales could be applied to a slide. Ages were determined from the slides using a microfiche projector with a 10-mm objective lens.

An in-season estimate of presmolt abundance was obtained at Salmon Lake using a mark-recapture experiment. Presmolt coho salmon were captured in the lake prior to any significant emigration (the first sampling event) using funnel traps baited with fresh salmon roe. Before release, the caudal fin of each presmolt was shallowly clipped as a temporary mark. Marked and unmarked fish were subsequently recaptured in fyke nets located downstream (the second sampling event). The abundance of coho salmon presmolt was estimated with Chapman's

modification of Petersen's method (Seber 1982):

$$\hat{N} = \frac{(M+1)(C+1)}{(R+1)} - 1 \quad (1)$$

$$V[\hat{N}] = \frac{\hat{N}(M-R)(C-R)}{(R+1)(R+2)} \quad (2)$$

where:

N = estimated abundance;  
M = number of marked fish released alive into the population during the first sampling event;  
C = number of fish caught in the second sampling event; and  
R = number of fish marked in the first event and recaptured during the second event.

Variances for proportions of estimated age-sex or age length groups were calculated using:

$$\hat{p}_i = \frac{y_i}{n} \quad (3)$$

$$V[p_i] = \left( \frac{\hat{p}_i(1-\hat{p}_i)}{(n-1)} \right) \left( 1 - \frac{n}{N} \right) \quad (4)$$

where:

$p_i$  = the proportion of fish from group  $i$  in the sample;  
 $y_i$  = the number of fish in group  $i$ ;  
 $n$  = the number of fish sampled; and  
 $N$  = the number of fish in the population.

### Adult Escapement

A weir was constructed at the outlet of Salmon Lake using an aluminum bipod and picket design. The bipods measured 2.4 x 2.4 x 2 m (8 x 8 x 6.5 ft) and were constructed from 6.25-cm (2.5 in), 5-cm (2 in), and 3.75-cm (1.5 in) extruded aluminum tubing, and 5- x 5- x 0.6-cm (2 x 2 x 0.25 in) aluminum channel. Pickets with 1.9-cm (0.75 in) diameters were spaced on 5.4-cm (2.125 in) centers. The weir was operated from 26 August to 29 September 1990. Water depth (nearest cm) and water temperature (nearest 0.5°C) were taken from 0800 to 1800 daily. Adult coho salmon were captured in a 2.4- x 2.4-m (8 x 8 ft) upstream migrant trap with a slot entrance, tranquilized with a 12-volt DC electric shocking basket (Gunstrom and Bethers 1985; Orsi and Short 1987), checked for the absence of an adipose fin (indicating the presence of a CWT), measured to the nearest 1 mm (mid-eye to fork of tail), sexed by examination of external characters, examined for hook wounds, and released alive on the upstream side of the weir.

A systematic sample of adults using a sampling interval of every third fish removed from the trap was taken at Salmon Lake throughout the season to collect data on age, sex, and length. Four scales were removed from the preferred area (Anas 1963), mounted on gum cards, pressed on acetate cards, and projected with a microfiche reader having an objective diameter of 10 mm. Variances for

proportions of estimated age-sex or age length groups were calculated with procedures listed in the section on smolt.

A weir was not installed at Eagle River in 1990, but a snorkel survey was conducted on 2 October to estimate the escapement and the fraction thereof with missing adipose fins.

### Estimated Harvest

The procedures listed in Clark and Bernard (1987) were used to estimate harvests in commercial fisheries of stocks tagged with CWTs. The estimates were based on the following information:

- 1) number of coho salmon harvested;
- 2) fraction of the harvest inspected for missing adipose fins;
- 3) number of coho salmon in the sample with missing adipose fins;
- 4) number of fish heads that reached the coded-wire tag lab;
- 5) number of these heads that contained CWTs;
- 6) number of these CWTs that were decodable;
- 7) number of decodable tags of the appropriate code(s); and
- 8) fraction of returning adults with tags.

The Alaska Department of Fish and Game, Commercial Fisheries Division inspected the harvest in troll and seine fisheries for coho salmon with coded-wire tags (missing adipose fins) and collected the heads. Heads were sent to the Head Lab, Fisheries Rehabilitation Enhancement and Development (FRED) Division, Alaska Department of Fish and Game for dissection. Fractions of adults with tags returning to Eagle River and Salmon Lake were estimated by this project. The Head Lab collected and provided all of the necessary information except that on fraction of returning adults with tags.

Calculation of troll harvest was stratified by fishing quadrant and by fishing period. Since information from FRED Division by fishing district are tallies from landings of fishermen that fished exclusively in that district, data from fishermen who fished several districts are excluded from the tallies. Since almost no fishermen fish in more than one of the larger quadrants during an opening, data stratified by quadrants are more comprehensive than data from fishing districts. Estimates were stratified by fishing period and by week. Stratification by fishing period produces more accurate estimates because of the delay between the inspection and the reporting of the catch. Inspection for missing adipose fins often occurs on tenders that deliver and record their catch 7-10 days later (Ben Van Alan, Alaska Department of Fish and Game, Juneau, personal communication). Under these circumstances, stratifications finer than 2 weeks would often bias the estimates. Since the samples drawn during each stratum will be independent samples, the estimate of total harvest will be the sum of all the stratified estimates. The variance of the total harvest will likewise be the sum of the stratified variances. Harvest rates were calculated as the estimated harvest of a stock (H) divided by the total estimated return of that stock (r). The variance of the harvest rate was approximated through the delta method:

$$V[E] \approx \frac{V[H] S^2}{r^4} \quad (5)$$

where:

E = the exploitation rate;  
H = the estimated harvest;  
S = the escapement; and  
r = the return (H+S).

The approximate variance of the smolt to adult survival rate was calculated as:

$$V[\theta] \approx \theta^2 \left[ \frac{V[r]}{r^2} + \frac{V[N]}{N^2} \right] \quad (6)$$

where:

$\theta$  = smolt-to-adult survival rate;  
r = number of returning adults; and  
N = number of smolts.

### Juvenile Population Estimates

Abundance of juvenile coho salmon at Sinitzin and St. John Creeks was estimated with Zippin's removal estimator (Seber 1982, pp. 59-60, 309-314):

$$\hat{N} = \frac{\sum_{j=1}^s U_j}{1 - q^s} \quad (7)$$

where:

$U_j$  = the number of unmarked fish captured during day j;  
s = the total number of sampling days in July; and  
q = the complement to the probability of capture.

The estimate of q is the solution of the following relationship:

$$\frac{q}{1-q} - \frac{sq^s}{1-q^s} = \frac{\sum_{j=1}^s (j-1)U_j}{\sum_{j=1}^s U_j} \quad (8)$$

The variance was calculated as:

$$V[\hat{N}] = \frac{\hat{N}(1-q^s)q^s}{(1-q^s)^2 - (1-q)^2 s^2 q^{s-1}} \quad (9)$$

Fish were captured, marked, and released during July 1990 in both streams. Minnow traps baited with frozen salmon roe were spaced evenly throughout 1-km sections of Sinitzin Creek and St. John Creek immediately upstream of the estuary. In both streams, each trap was checked daily and reset in the same location. All captured fish  $\geq 65$ -mm fork length were marked by shallowly clipping the dorsal lobe of the caudal fin and then released away from their site of capture. The first 120 unmarked fish captured in each system were measured to the nearest millimeter fork length and sampled for scales.

## RESULTS

### Salmon Lake

Based on data collected in 1989 and 1990, an estimated 9,490 (SE = 540) smolt emigrated from Salmon Lake in 1989. There were 6,437 smolt released with adipose fin clips in spring 1989, 6,401 of which had CWT with code 4/28/27. Eighty-one (81) tags from Salmon Lake with code 4/28/27 were recovered in the 1990 coho salmon troll fishery. At the weir on Salmon Lake, 142 adult coho salmon were inspected for adipose clips, and 96 marked fish were observed.

The escapement of coho salmon to Salmon Lake was an estimated 204 adults (Appendix A1). This estimate is the sum of: 1) 142 fish examined and counted through the weir, and 2) a minimum of 62 fish that swam over the weir during flooding on 22-24 September. Some adult salmon may have passed over the weir unobserved at this time, but it is unlikely that large numbers of fish swam by undetected. Since no fish were observed in the outlet stream before 3 September, and since large numbers of coho salmon have not passed through the Salmon Lake weir in early September in prior years, it is unlikely that many fish passed over the weir unobserved during the flood on 4 September. Further, adult salmon were not seen in the stream section below the weir prior to the high water on 28-29 September, nor were any fish captured in the migrant trap during the period of rising stream levels antecedent to this event; it is again unlikely that many fish passed over the weir undetected during this episode of flooding. The weir was taken out on 29 September.

The estimated harvest of coho salmon bound for Salmon Lake included 531 (SE = 55) fish caught in the commercial troll fishery, and 27 (SE = 10) fish in the purse seine fishery (Table 1). No creel census was conducted in Sitka during the coho salmon season, but sport fishermen turned in 12 coho salmon heads that had Salmon Lake tags. Expansion of the sport tags by the tagged ratio indicates a minimum harvest of 18 coho salmon by sport anglers. Total production is the sum of the troll harvest (531), purse seine harvest (27), sport harvest (18), and escapement (204), or 780 coho salmon. The harvest rate by the commercial troll fishery was 531/780, or 68.1% (SE = 2.0%). The estimated smolt to adult survival rate was 780/9490, or 8.2% (SE  $\approx$  0.7%).

Age-3.1 coho salmon adults were the most abundant (61.1%), followed by age-2.1 fish (38.9%). Age-4.1 coho salmon were absent from the sample (Table 2). Relative occurrence of males (47.4%) was similar to that of females (52.6%).

An estimated 15,414 (SE = 637) presmolts were extant in Salmon Lake in spring 1990. Between 24 March and 1 April 1990, 517 presmolts  $\geq$ 85-mm fork length were marked in the lake. During the spring emigration, 269 of these marked presmolts were captured as part of the total catch of 8,034 smolts (Appendix A2).

From 22 March through 19 May 1990, 7,814 of the 8,034 smolt captured were tagged with CWTs. There were 206 pre-tagging mortalities, 151 post-tagging mortalities, and 14 previously coded-wire tagged fish that had tags from earlier years.

Table 1. The estimated harvest of Salmon Lake coho salmon by the commercial fishery by statistical week and by period in 1990. Of 204 fish in the escapement, 142 were examined for adipose fin clips; 96 (67.6%) were missing these fins. The coded-wire tag code was 4/28/27.

Stat. Week	Per.	Date	Area		N Catch	n2 Sample	mc Tag	m1 Detect	m2 Decod	a1 Ad Cl	a2 Heads	n1	
			Quad.	Dist.								Est. Catch	SE
Troll Fishery													
27	5	01-Jul - 07-Jul	NW	-	30,181	3,870	2	57	57	61	61	23	16
28	5	08-Jul - 14-Jul	NW	-	60,354	11,791	9	149	149	182	181	69	21
29	5	15-Jul - 21-Jul	NW	-	117,145	18,884	17	275	274	328	328	157	36
29	5	15-Jul - 21-Jul	SW	-	73,095	26,834	2	309	309	381	369	8	5
30	5	22-Jul - 28-Jul	NW	-	96,724	23,834	7	270	270	339	337	42	15
30	5	22-Jul - 28-Jul	SE	-	14,845	5,012	1	79	79	100	99	4	4
31	6	29-Jul - 04-Aug	NW	-	171,901	41,651	17	593	592	717	711	105	23
31	6	29-Jul - 04-Aug	SW	-	46,027	13,362	1	177	176	218	213	5	5
32	6	05-Aug - 11-Aug	NW	-	128,453	29,571	6	451	451	531	524	39	15
33	6	12-Aug - 18-Aug	NW	-	107,494	38,910	12	581	581	678	671	50	12
34	7	19-Aug - 25-Aug	NW	-	76,153	10,444	6	184	184	214	214	65	25
35	7	26-Aug - 01-Sep	NE	-	17,985	3,904	1	62	62	72	72	7	6
Troll Fishery Harvest by Stat. Week					940,357	228,067	81	3,187	3,184	3,821	3,780	573	62
27-30	5	01-Jul - 28-Jul	NW	-	304,404	58,379	35	751	750	910	907	271	43
27-30	5	01-Jul - 28-Jul	SE	-	66,278	23,028	1	394	394	477	465	4	4
27-30	5	01-Jul - 28-Jul	SW	-	210,872	73,792	2	843	842	1,045	1,012	9	5
31-33	6	29-Jul - 18-Aug	NW	-	407,848	110,132	35	1,625	1,624	1,926	1,906	194	30
31-33	6	29-Jul - 18-Aug	SW	-	99,994	27,675	1	404	403	486	480	5	5
34-39	7	19-Aug - 29-Sep	NW	-	369,838	85,375	7	1,438	1,437	1,744	1,647	48	17
Troll Fishery Harvest by Period					1,459,234	378,381	81	5,455	5,450	6,588	6,417	531	55
Purse Seine fishery =													
27	-	01-Jul - 07-Jul	-	104	25,348	10,631	1	109	109	137	132	4	3
28	-	08-Jul - 14-Jul	-	104	25,821	8,833	2	100	100	125	120	9	6
29	-	15-Jul - 21-Jul	-	104	10,447	3,229	1	32	31	38	37	5	5
30	-	22-Jul - 28-Jul	-	104	2,349	1,041	1	15	15	20	20	3	3
31	-	29-Jul - 04-Aug	-	104	45,060	10,795	1	158	158	187	183	6	6
Purse Seine Harvest					109,025	34,529	6	414	413	507	492	27	10
Total commercial harvest =					1,568,259	412,910	87	5,869	5,863	7,095	6,909	558	56

Table 2. Mean length (mm mid-eye to fork of tail), age, and sex composition of age-.1 adult coho salmon sampled at Salmon Lake weir, 26 August to 29 September 1990.

		Parent Year		Total
		1986 Age 2.1	1985 Age 3.1	
Male	N	7	11	18
	Mean Length	575	626	606
	SD	89	53	67
	SE	33	16	16
	Percent Composition	38.9	61.1	47.4
	SE (%)			7.4
Female	N	5	15	20
	Mean Length	639	676	667
	SD	43	31	37
	SE	19	8	8
	Percent Composition	25.0	75.0	52.6
	SE (%)			7.4
Total	N	12	26	38
	Mean Length	602	655	638
	SD	78	48	52
	SE	22	9	8
	Percent Composition	31.6	68.4	100.0
	SE (%)	6.9	6.9	

Of the 4,911 tagged smolt held for 24 hours, 4,807 (97.9%) retained their tags. Since fish in the retention sample that shed their tags were retagged, and since retention rates were calculated daily and weighted by the number of fish tagged the previous day, a slightly higher overall retention rate (98.8%) resulted for the tagged population than that noted above. There were 7,572 fish released with the valid tag code 4/28/48, and 91 adipose clipped smolt that did not retain tags.

Most smolts were age-3. (48.6%), with lesser numbers of age-2. (30.3%), age-4. (19.4%), age-5. (1.3%), and age-1. (0.4%) smolts. Average length of age-3. smolts was 120-mm fork length, while age-2. smolts averaged 97 mm and age-4. smolts averaged 131 mm (Table 3).

### Eagle River

Mark-recapture data collected during 1989 and 1990 yielded an estimate of 10,885 (SE = 2,379) smolt that emigrated from Eagle River in 1989. There were 3,047 smolts released with adipose fin clips in spring 1989, 3,031 of which had CWTs with code 4/28/38. Twenty (20) tags from Eagle River with code 4/28/38 were recovered in the 1990 coho salmon troll fishery. During the 2 October 1990 snorkel survey, 49 adult coho salmon were examined for adipose fin clips and 13 marks were observed.

The escapement of adult coho salmon to Eagle River was estimated at 214 fish during the 2 October survey. Signs of spawning activity were not evident at this time.

The estimated harvest of coho salmon bound for Eagle River included 325 (SE = 72) fish caught in the commercial troll fishery, and 14 (SE = 13) fish in the purse seine fishery (Table 4). No creel census was conducted, and sport fishermen turned in only one tagged head from Eagle River. Total estimated coho salmon production is the sum of the troll harvest (325), purse seine harvest (14), sport fish harvest (1), and escapement (214), or 554 coho salmon. The harvest rate by the commercial troll fishery was 325/554, or 58.7% (SE = 5.0%). The estimated smolt to adult survival rate was 554/10,885, or 5.1% (SE  $\approx$  1.3%).

From 20 April through 20 May 1990, 2,880 smolts were captured (Appendix A3). There were 21 pre-tagging and 16 post-tagging mortalities. Of the 2,739 smolts held for 24 hours, 2,737 (99.9%) retained their tags. Retention rates were calculated daily, and their application was weighted by the number of fish tagged the previous day. The number of smolts tagged during spring 1990 was 2,859. There were 2,840 fish released with the valid tag code 4/33/36, and 3 adipose clipped fish which did not retain tags.

Coho smolts were mostly aged 2. (81.4%), with a few age-1. (11.0%) and age-3. (7.6%) fish. Age-2. smolts averaged 78-mm fork length, while age-1. and age-3. smolts were 69-mm and 91-mm fork length, respectively (Table 5).



Table 3. Mean fork length (mm) and age composition of coho salmon smolts sampled at Salmon Lake weir, 22 March to 19 May 1990.

	Parent Year					Total
	<u>1988</u> Age 1.	<u>1987</u> Age 2.	<u>1986</u> Age 3.	<u>1985</u> Age 4.	<u>1984</u> Age 5.	
N	2	145	233	93	6	479
Mean Length	84	97	120	131	140	115
SD	2	10	14	13	8	13
SE	2	0.8	0.9	1	3	0.6
Percent Composition	0.4	30.3	48.6	19.4	1.3	100.0
SE (%)	0.3	2.1	2.2	1.8	0.5	

Table 4. The estimated harvest of Eagle River coho salmon by the commercial fishery by statistical week and by period in 1990. Of 214 fish in the escapement, 49 were examined for adipose fin clips; 13 (26.5%) were missing these fins. The coded-wire tag code was 4/28/38.

Stat. Week	Per.	Date	Area		N Catch	n2 Sample	mc Tags	m1 Detected	m2 Decoded	a1 Ad Clip	a2 Heads	n1	
			Quad.	Dist.								Est. Catch	SE
Troll Fishery													
28	5	08-Jul - 14-Jul	NW	-	60,354	11,791	1	149	149	182	181	19	19
28	5	08-Jul - 14-Jul	NE	-	13,826	5,276	3	56	56	73	73	30	16
29	5	15-Jul - 21-Jul	NW	-	117,145	18,884	3	275	274	328	328	70	40
29	5	15-Jul - 21-Jul	NE	-	17,377	6,514	1	86	85	108	108	10	10
30	5	22-Jul - 28-Jul	NW	-	96,724	23,834	4	270	270	339	337	62	30
31	6	29-Jul - 04-Aug	NW	-	171,901	41,651	3	593	592	717	711	47	26
32	6	05-Aug - 11-Aug	NW	-	128,453	29,571	1	451	451	531	524	17	16
33	6	12-Aug - 18-Aug	NW	-	107,494	38,910	2	581	581	678	671	21	14
34	7	19-Aug - 25-Aug	NW	-	76,153	10,444	1	184	184	214	214	27	27
38	7	16-Sep - 22-Sep	NW	-	15,532	11,391	1	197	197	225	222	5	5
Troll Fishery Harvest by Stat. Week					804,959	198,266	20	2,842	2,839	3,395	3,369	309	71
27-30	5	01-Jul - 28-Jul	NW	-	304,404	58,379	8	751	750	910	907	158	54
27-30	5	01-Jul - 28-Jul	SE	-	66,278	23,028	1	394	394	477	465	11	11
27-30	5	01-Jul - 28-Jul	NE	-	55,265	17,216	3	203	202	259	257	37	20
31-33	6	29-Jul - 18-Aug	NW	-	407,848	110,132	6	1,625	1,624	1,926	1,906	85	33
34-39	7	19-Aug - 29-Sep	NW	-	369,838	85,375	2	1,438	1,437	1,744	1,647	35	24
Troll Fishery Harvest by Period					1,203,633	294,130	20	4,411	4,407	5,316	5,182	325	72
Purse Seine fishery =													
28	-	08-Jul - 14-Jul	-	104	25,821	8,833	1	100	100	137	132	14	13
Purse Seine Harvest =					25,821	8,833	1	100	100	137	132	14	13
Total Commercial Harvest =					1,229,454	302,963	21	4,511	4,507	5,453	5,314	339	73

Table 5. Mean fork length (mm) and age composition of coho salmon smolts sampled at Eagle River, 20 April to 20 May 1990.

	Parent Year			Total
	<u>1988</u> Age 1.	<u>1987</u> Age 2.	<u>1986</u> Age 3.	
N	58	430	40	528
Mean Length	69	78	91	78
SD	8	9	8	9
SE	1	0.4	1	0.4
Percent Composition	11.0	81.4	7.6	100.0
SE (%)	1.2	1.5	1.0	

### Juvenile Population Estimates

An estimated 1,533 (SE = 38) juvenile coho were extant in Sinitsin Creek in July 1990, and 684 (SE = 15) were present in St. John Creek (Table 6). Juvenile coho salmon sampled at Sinitsin Creek were nearly all aged 1. (95.9%), with few age-2. (4.1%) fish present. Juvenile coho salmon at St. John Creek were primarily age-1. (79.0%), with less age-2. (21.0%) fish. The mean length of age-1. and age-2. fish in Sinitsin Creek was 73 mm and 77 mm, respectively; in St. John Creek, the mean length of age-1. fish was 77 mm and age-2. fish was 81 mm. Daily catches of juvenile coho salmon in both Sinitsin and St. John Creeks remained nearly constant, while the number of unmarked fish usually decreased daily (Table 7).

The estimated number of juvenile coho salmon by age class, and the age-1. juvenile per spawner production ratios for the 1985-88 brood years are presented in Table 8. The number of age-1. juvenile coho salmon per parent was 26.2 in Sinitsin Creek and 7.6 in St. John Creek during 1990.

### DISCUSSION

The smolt population which emigrated from Salmon Lake in 1989 ( $n = 9,490$ ), and the subsequent adult return in 1990 ( $n = 780$ ) were the lowest since this study began in 1984. This reduction in size of coho populations in Sitka Sound is not limited to Salmon Lake, but is also evident in other nearby coho producing systems where escapement surveys are conducted. The estimated smolt emigration during the spring of 1990 was increased with presmolt population estimate of 15,414. The smolt-to-adult survival rate increased to 8.1% this year from 5.6% in 1989. The troll harvest rate of the Salmon Lake coho stock was 68.1% in 1990 compared to 71.6% in 1989.

The smolt population that emigrated from the Eagle River area in 1989 ( $n = 10,885$ ) resulted in production of an estimated 554 adult coho salmon for a smolt-to-adult survival ratio of 5.1%. This is much higher than the smolt-to-adult survival of 2.3% at Eagle River last year. Harvest rate of this stock by the troll fishery was 58.7% this year compared to 50.2% last year.

An estimate of the smolt production from Eagle River is not easily obtained, as many of the smolts leaving the system are not intercepted by the fyke nets fished on the main river channel. A preliminary estimate of the presmolt population emigrating from the main river was 4,948 in the spring of 1988 (Elliott et al. 1989). The final estimate of this smolt population was 11,251 (Schmidt 1990), indicating that more than half of the smolts are not available for capture in fyke nets fished in the main river during emigration. During spring 1989, coho smolts were trapped with baited minnow traps in the estuary and side channels of the intertidal area below the fyke nets. This trapping revealed many untagged smolts, indicating they had not been exposed to capture at the fyke traps. During the spring 1988 fyke netting operations, 31.7% (3,573/11,251) of the smolt population from the Eagle River system were captured in the main channel, and in 1989 only 29.9% (3,259/10,885) of the smolts were captured in the main river channel. There were 2,880 smolts captured in fyke nets during spring 1990, suggesting a possible smolt emigration of about 9,600 (2,880/.3).

Table 6. Population estimates, age composition, and mean length at age of juvenile coho salmon  $\geq 65$ -mm fork length at Sinitsin and St. John Creeks, July 1990.

Sinitsin Creek		St. John Creek	
N	1,533	N	684
Variance of N	1,467	Variance of N	218
SE	38	SE	15
No. of age-1.+	1,470	No. of age-1.+	540
% composition	95.9	% composition	79.0
SE (%)	0.5	SE (%)	1.6
No. of age-2.+	63	No. of age-2.+	144
% composition	4.1	% composition	21.0
SE (%)	5.1	SE (%)	1.6
n	116	n	94
Mean length of age-1.+	73	Mean length of age-1.+	77
SD	6.1	SD	6.3
SE	0.6	SE	0.7
n	5	n	25
Mean length of age-2.+	77	Mean length of age-2.+	81
SD	5.7	SD	7.4
SE	2.5	SE	1.5

Table 7. Daily catch and number of unmarked juvenile coho salmon  $\geq 65$ -mm length, by day, at Sinitsin and St. John Creeks, July 1990.

Sinitsin Creek (21 traps/sample)			St. John Creek (21 traps/sample)		
<u>Number caught</u>			<u>Number caught</u>		
Date	Total	Unmarked	Date	Total	Unmarked
12 July	206	206	06 July	285	285
13 July	390	340	09 July	209	142
16 July	323	211	10 July	104	51
17 July	254	107	11 July	178	92
23 July	440	212	27 July	104	47
24 July	301	96			
25 July	186	38			
26 July	224	58			

Table 8. Summary of available juvenile-per-spawner production ratios for coho salmon from Sinitsin and St. John Creeks, 1985 to 1990.

Escapement index (yr)	Juvenile population estimate at (yr) + 2			Adult return at (yr) + 4	No. age-1. juvenile/ parent escapement
	Age-1.+	Age-2.+	Total		
<u>Sinitstin Creek</u>					
144 (85) <sup>a</sup>	921	19	940	76	6.4
4 (86)	76	57	133	80	19.0
32 (87)	655	120	775		20.5
56 (88)	1,470	63	1,533		26.2
76 (89)					
80 (90)					
<u>St. John Creek</u>					
109 (85) <sup>a</sup>	1,027	66	1,093	89	9.4
9 (86)	546	164	710	38	60.6
9 (87)	512	26	538		56.9
71 (88) <sup>b</sup>	540	144	684		7.6
89 (89)					
38 (90)					

<sup>a</sup> Very cold winter with no snow cover may have frozen embryos.

<sup>b</sup> Dynamic high water event during winter 1989-90.

Juvenile-per-spawner ratios have varied considerably by system and year at Sinitsin and St. John Creeks. The low ratios observed in both creeks from the high escapement of 1985 (Sinitsin 6.4, St. John 9.4) could be attributed to the severe winter of 1985-86 when excessively high embryo mortality may have occurred. The sudden decrease in the juvenile-per-spawner ratio observed in St. John Creek for the relatively high escapement year of 1988 may be the result of the flushing effect of an extreme flood that occurred during the winter of 1989-90.

Adult returns to Sinitsin and St. John Creeks have begun to exhibit unexpected variability. The adult return in 1990 from the low parent escapement year of 1986 (Sinitsin 4, St. John 9) was 80 fish to Sinitsin Creek, but only 38 fish to St. John Creek. This is unusual since there was a higher juvenile-per-spawner ratio in St. John Creek than in Sinitsin Creek for the 1986 escapement (Sinitsin 19.0, St. John 60.6).

#### ACKNOWLEDGMENTS

Sincere gratitude goes to Fishery Technicians Bob Chadwick and John Vallie who labored long hours on the fyke nets and weir. David R. Bernard provided biometric support and edited the manuscript.



#### LITERATURE CITED

- Anas, R. E. 1963. Red salmon scale studies, p. 114-116 in: Annual Report of the International North Pacific Fisheries Commission, 1961, Vancouver, British Columbia, Canada.
- Clark, J. E. and D. R. Bernard. 1987. A compound multivariate binomial-hypergeometric distribution describing coded microwire tag recovery. Department of Fish and Game, Informational Leaflet No. 261.
- Elliott, S. T., A. E. Schmidt, and D. A. Sterritt. 1989. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game, Fisheries Data Series No. 113.
- Gunstrom, G. K., and M. Bethers. 1985. Electrical anesthesia for handling large salmonids. Progressive Fish-Culturist 47:67-69.
- Koerner, J. F. 1977. The use of the coded-wire tag injector under remote field conditions. Alaska Department of Fish and Game, Informational Leaflet No. 172, Juneau, Alaska.
- Orsi, J. A., and J. W. Short. 1987. Modifications in electrical anesthesia for salmonids. Progressive Fish-Culturist 49(2):144-146.
- Schmidt, A. E. 1984. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1983-1984, Project AFS51-1, Vol. 25.
- \_\_\_\_\_. 1985. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1984-1985, Project G-II-D, Vol. 26.
- \_\_\_\_\_. 1986. A study of coho salmon in southeast Alaska. Alaska Department of Fish and Game. Federal Aid in Fish Restoration, Annual Report of Performance, 1985-1986, Project S1-4, Vol. 27.
- \_\_\_\_\_. 1987. Coho salmon in southeast Alaska. Alaska Department of Fish and Game, Fisheries Data Series No. 18.
- \_\_\_\_\_. 1988. Coho salmon in southeast Alaska. Alaska Department of Fish and Game, Fisheries Data Series No. 45.
- \_\_\_\_\_. 1990. A study of coho salmon in southeast Alaska, 1989: Salmon Lake, Eagle River, St. John and Sinitzin Creeks. Alaska Department of Fish and Game, Fisheries Data Series No. 90-12.
- Seber, G. A. F. 1982. On the estimation of animal abundance and related parameters, second edition. Charles Griffin and Sons, Ltd., London.

## APPENDIX A

Appendix A1. Daily counts of coho salmon, water temperature, stream depth, and rainfall at the Salmon Lake weir, 1990.

Date	Average water temp. (°C)	Maximum stream depth (cm)	Previous 24-hour rainfall (inches)	Number adult coho	Number jack coho
26 Aug		37	0.0	0	0
27 Aug	15.0	36	0.1	0	0
28 Aug	14.0	43	0.5	0	0
29 Aug	14.0	43	1.8	0	0
30 Aug	14.0	40	0.1	0	0
31 Aug	14.0	38	0.1	0	0
01 Sep	14.0	36	0.0	0	0
02 Sep	14.5	36	0.2	0	0
03 Sep	13.5	38	0.2	0	0
04 Sep	12.0	121 <sup>a</sup>	4.8	0	0
05 Sep	13.0	71	1.4	1	1
06 Sep	12.5	46	0.1	0	0
07 Sep	12.5	45	0.3	4	1
08 Sep	12.5	40	0.0	4	1
09 Sep			0.0	0	0
10 Sep	12.5	37	0.4	0	2
11 Sep	12.5	38	0.8	0	0
12 Sep	12.0	38	0.1	0	0
13 Sep	12.5	38	0.4	0	0
14 Sep	12.5	43	0.0	0	0
15 Sep	12.5	59	0.8	5	0
16 Sep	12.5	56	0.4	0	0
17 Sep	12.0	44	0.2	3	0
18 Sep	11.0	53	0.8	0	0
19 Sep	11.0	53	0.6	4	2
20 Sep	10.5	58	1.2	29	0
21 Sep	10.5	130		13	0
22 Sep	11.0	114 <sup>a</sup>	2.1	141 <sup>b</sup>	1
23 Sep	11.0	118 <sup>a</sup>	3.6	0	0
24 Sep	10.5	121 <sup>a</sup>	3.2	0	0
25 Sep	10.5	86	2.6	0	0
26 Sep	10.5	54	0.2	0	0
27 Sep	10.0	42	0.0	0	0
28 Sep	9.0	130 <sup>a</sup>	2.0	0	0
29 Sep	8.5	91 <sup>a</sup>	3.9	0	0
				204	8

<sup>a</sup> Weir overtopped.

<sup>b</sup> Includes 62 adults counted over top of weir.

Appendix A2. Daily catches of fish and measurements of rainfall, water temperature, and maximum stream depth at the site of the fyke net on the outlet stream from Salmon Lake, 1990.

Date	Previous 24-hour rainfall (inches)	Mean water temp. (°C)	Maximum stream depth (cm)	Dolly Varden	Smolts		
					SS <sup>a</sup>	SH <sup>b</sup>	RS <sup>c</sup>
22 Mar				12	0	0	0
23 Mar	0.00		41	22	0	0	0
24 Mar	0.00		40	10	0	0	0
25 Mar	0.20	1.5	41	22	41	0	0
26 Mar	0.10	1.5	46	37	6	0	0
27 Mar	0.20	1.5	98 <sup>d</sup>	0	0	0	0
28 Mar	1.10	1.5	94 <sup>d</sup>	0	0	0	0
29 Mar	1.70	2.0	97 <sup>d</sup>	0	0	0	0
30 Mar	0.20	1.5	67	94	25	1	0
31 Mar	0.45	1.5	53	61	13	0	0
01 Apr	0.20	1.5	48	89	18	0	0
02 Apr	0.10	1.5	47	51	21	0	0
03 Apr	0.25	1.5	47	52	32	2	0
04 Apr	0.50	1.0	46	125	18	0	0
05 Apr	0.70	2.0	51	93	28	0	0
06 Apr	0.00	2.0	47	8	17	0	0
07 Apr	0.00	2.0	46	52	14	0	0
08 Apr	0.00	2.0	44	376	58	1	0
09 Apr	0.00	2.0	44	210	30	0	0
10 Apr	0.00	2.5	43	291	39	0	0
11 Apr	0.00	2.0	44	262	13	0	0
12 Apr	0.50	2.0	51	706	59	0	0
13 Apr	0.00	2.0	64	763	33	0	0
14 Apr	0.00	2.0	68	981	85	2	0
15 Apr	0.00	2.0	62	996	67	2	0
16 Apr	0.00	2.5	65	40	53	1	0
17 Apr	trace	2.5	67	1,022	74	2	0
18 Apr	0.10	3.0	62	556	64	2	1
19 Apr	0.70	3.0	76 <sup>e</sup>	0	0	0	0
20 Apr	0.50	3.0	74 <sup>e</sup>	0	0	0	0
21 Apr			<sup>e</sup>	0	0	0	0
22 Apr			<sup>e</sup>	0	0	0	0
23 Apr	0.00	3.5	53	131	108	1	1
24 Apr	0.30	4.0	53	347	173	1	0
25 Apr	0.25	4.0	53	245	162	0	0

-continued-

Appendix A2. (Page 2 of 2).

Date	Previous 24-hour rainfall (inches)	Mean water temp. (°C)	Maximum stream depth (cm)	Dolly Varden	Smolts		
					SS <sup>a</sup>	SH <sup>b</sup>	RS <sup>c</sup>
26 Apr	0.00	5.0	52	129	78	1	2
27 Apr	0.00	5.0	52	258	127	4	0
28 Apr	0.00	5.0	52	0	135	2	0
29 Apr	0.00	6.0	52	132	98	0	0
30 Apr	0.00	5.5	52	72	126	2	1
01 May	0.35	6.0	50	90	184	1	1
02 May	0.15	5.5	51	41	669	4	2
03 May	0.50	5.0	68	120	227	1	0
04 May	0.80	5.5	78	15	357	1	0
05 May	0.00	5.0	62	0	347	1	0
06 May	0.10	5.5	52	2	145	0	0
07 May	trace	5.5	51	3	243	1	0
08 May	0.48	5.0	54	6	449	1	1
09 May	0.10	5.0	54	8	481	2	0
10 May	0.10	5.5	56	0	544	2	0
11 May	0.10	5.5	54	3	431	0	3
12 May	0.10	6.0	55	5	426	1	6
13 May	trace	6.0	52	4	413	2	8
14 May				4	0	4	15
15 May	0.00	7.0	49	2	297	1	6
16 May	0.00	7.0	48	0	224	1	23
17 May	0.00	7.0	48	1	64	1	37
18 May	trace	7.0	50	0	73	1	43
19 May	0.00	7.0	53	0	105	3	9
				8,909	8,034	52	241

<sup>a</sup> Coho salmon.

<sup>b</sup> Steelhead.

<sup>c</sup> Sockeye salmon.

<sup>d</sup> Fyke nets washed-out.

<sup>e</sup> High water, fyke nets deactivated.

Appendix A3. Daily catches of fish and measurements of water temperature and maximum stream depth at the site of the fyke net on Eagle River, 1990.

Date	Mean water temp. (°C)	Maximum stream depth (cm)	Dolly Varden	Smolts	
				SS <sup>a</sup>	SH <sup>b</sup>
20 Apr		19	75	49	2
21 Apr		19	59	124	0
22 Apr		18	47	148	0
23 Apr		18	9	45	0
24 Apr		17	29	70	0
25 Apr	4.0	16	30	25	0
26 Apr	5.5	16	63	36	0
27 Apr	5.5	16	81	117	0
28 Apr	5.0	15	55	74	0
29 Apr	6.0	14	62	51	0
30 Apr	4.5	18	50	60	0
01 May	5.0	18	51	114	0
02 May	5.5	18	42	100	2
03 May	5.0	39	218	308	1
04 May	4.5	86 <sup>c</sup>			
05 May	5.5	36	30	76	0
06 May	5.5	26	26	105	1
07 May	5.5	22	20	160	0
08 May	5.0	25	15	68	0
09 May	6.0	22	18	195	2
10 May	5.5	20	18	145	0
11 May	6.0	19	6	137	0
12 May	7.0	19	12	105	0
13 May	7.0	18	9	70	1
14 May	7.0	18	10	144	0
15 May	7.0	17	3	79	1
16 May	7.5	16	8	101	1
17 May	7.5	16	10	57	1
18 May	7.0	16	4	55	1
19 May	8.0	15	1	31	1
20 May	7.0	14	4	31	0
			1,065	2,880	14

<sup>a</sup> Coho salmon.

<sup>b</sup> Steelhead.

<sup>c</sup> Fyke nets washed out.

